

SPECIAL SPECIFICATION

5999

Lift Station

- 1. Description.** Furnish labor, materials, equipment, tools, and other facilities and services necessary to provide a complete lift station in compliance with the plans, specifications, and all applicable codes including ANSI, AWWA, ASTM, ASA, NEC, and local building codes. This includes testing and startup of all systems and the completed system. The work includes all civil, mechanical, structural, architectural, electrical, and instrumentation. All miscellaneous appurtenances and other items or work that are incidental to meeting the intent of these specifications shall be considered as having been included in the applicable bid prices for the various items of work, even though these appurtenances and items may not be specifically called for in the specifications.

The abbreviations AISC, ANSI, AWWA, ASTM, ASA, ICEA, IEEE, NEC, and NEMA in this specification refer to the following organizations:

- AISC - American Institute of Steel Construction
- ANSI - American National Standards Institute
- AWWA - American Water Works Association
- ASTM - American Society for Testing and Materials
- ASA - American Standards Association
- ICEA - Insulated Cable Engineers Association
- IEEE - Institute of Electrical and Electronics Engineers
- NEC - National Electric Code
- NEMA - National Electrical Manufacturers Association

When referring to the specifications of the above organizations, it means the latest standard or tentative standard in effect on the date of the proposal.

The size and location of utility lines shown on the plans were obtained from field surveys and from the various utility companies. The Department does not assume responsibility for the accuracy of the information presented, nor does it warrant that all of the utility lines are shown.

Prior to final inspection or acceptance fully instruct Owner's designated operating and maintenance personnel in operation, adjustment, and maintenance of products, equipment, and systems.

- 2. Materials.** Furnish new and unused materials for this project unless otherwise specified on the plans. Provide a manufacturer's certificate of compliance for quality control of materials unless otherwise shown on the plans. Unless specifically named in the specifications, a manufacturer shall have furnished equipment of the type and size specified, that has been in successful operation for not less than the past 5 years.

Submit shop drawings for fabrication and erection, dimensioned drawings, list, schedules, catalog sheets, specification sheets, certifications, laboratory, shop, or mill test reports, basis of design and design calculations, test procedures, samples, and parts list.

- A. General Material and Equipment Stipulations.** In addition to the general guarantee required by this contract, the manufacturer shall furnish a written warranty that all materials provided under this section are free from defects for a period of one year from the date of project Final Acceptance.

1. Contractor's Selection of Materials and Equipment.

- a. Coordinate all details of the equipment with other related parts of the Work, including verification that all structures, piping, wiring, and equipment components are compatible.
- b. For products specified only by reference standard, select a product meeting that standard.
- c. For products specified by naming several products or manufacturers, select any one of the products or manufacturers named, which complies with the specifications.
- d. For products specified by naming one or more products or manufacturers and "or approved equal", the Contractor must submit a request for substitution for any product or manufacturer not specifically named.
- e. For products specified by naming only one product and manufacturer, there is no option.

2. Substitutions.

- a. The Contractor shall be responsible for all structural and other alternations in the Work required to accommodate equipment differing in parameters, dimensions, or other characteristics from that contemplated on the drawings and specifications.
- b. For a period of 30 days after contract date, the Engineer will consider written requests from the Contractor for substitution of products or manufacturers.
- c. The Contractor shall submit a separate request for each product or manufacturer, supported with complete data, with drawings and samples as appropriate, including:

- (1) Comparison of the qualities of the proposed substitution with that specified.
 - (2) Changes required in other elements of the work because of the substitution.
 - (3) Effect on the construction schedule.
 - (4) Cost data comparing the proposed substitution with the product specified.
 - (5) Listing of any required license fees or royalties.
 - (6) Availability of maintenance service, and source of replacement materials.
- d. The Engineer shall be the sole judge of the acceptability of the proposed substitution.
- e. In submitting a request for a substitution, the Contractor represents to the Owner and Engineer that he:
- (1) Has investigated the proposed product and determined that it is equal to or superior in all respects to that specified.
 - (2) Will provide the same or superior warranties or bonds for the substitution as for the product specified.
 - (3) Will coordinate the installation of an accepted substitution into the work, and make all other changes as may be required to make the work complete in all respects.
 - (4) Waives all claims for additional costs, under his responsibility, which may subsequently become apparent.
- f. The Engineer will review requests for substitutions with reasonable promptness, and notify Contractor, in writing, of the decision to accept or reject the requested substitution. The Engineer shall be the sole judge of the acceptability of any proposed substitution.
- g. Structural, mechanical, and electrical changes that are necessitated because the Contractor selects equipment with dimensional, power, or mechanical differences from that shown on the drawings shall be made by the Contractor at no additional cost to the Owner. All engineering costs associated with revisions shall be borne by the Contractor.

3. Workmanship and Materials.

- a. The Contractor shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure for a period of one year from date of project Final Acceptance. Materials shall be suitable for service conditions.
- b. All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field.

Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.

- c. Except where otherwise specified, structural and miscellaneous fabricated steel used in equipment shall conform to AISC standards. All structural members shall be designed for shock or vibratory loads. Unless otherwise specified, all steel which will be submerged, all or in part, during normal operation of the equipment shall be at least 1/4 in. thick.
- d. Manufacturer shall supply to the Owner a Certificate of Compliance on equipment furnished that it meets the specification requirements.

4. Lubrication

- a. Equipment shall be adequately lubricated by systems, which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown, and shall not waste lubricants.
- b. Lubrication of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs, and replace all consumption during testing, startup, and operation prior to acceptance of equipment by the Owner. Unless otherwise specified, the use of synthetic lubricants will not be acceptable.
- c. Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

5. Electrical Motors. Unless otherwise specified, motors furnished with equipment shall meet the following requirements:

- a. Designed and applied in accordance with NEMA, ANSI, IEEE, AFBMA, and NEC for the duty service imposed by the driven equipment such as frequent starting, intermittent overload, high inertia, mounting configuration, or service environment.
- b. Rated for continuous duty at 40°C ambient.
- c. Insulated with a Class F insulation system and designed for a maximum Class B temperature rise at service factor load (80°C at 1.0 or 90°C at 1.15), or insulated with a Class H insulation system and designed for a maximum Class F temperature rise at service factor load (145°C at 1.0).
- d. Motors used in applications which exceed the usual service conditions as defined by NEMA, such as higher than 40°C ambient, altitude exceeding 1,005 m (3,300 ft.), explosive or corrosive environments, departure from rated voltage and frequency, poor ventilation, frequent starting, or adjustable frequency drive applications, shall be properly selected with respect to their service conditions, and shall not exceed specified temperature rise limits.

- e. To ensure long life, motors shall have nameplate horsepower (kilowatts) equal to or greater than the maximum load imposed by the driven equipment, and shall carry a service factor rating of 1.15.
- f. Designed for full voltage starting.
- g. Designed to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.
- h. Clamp-type grounding terminal shall be inside motor conduit box.
- i. External conduit boxes shall be oversized at least one size larger than NEMA standard.
- j. Totally enclosed motors shall have a continuous moisture drain, which also excludes insects.
- k. Bearings shall be grease lubricated.
- l. Manufacturer's standard motor may be supplied on appliances, tools, and unit heaters, in cases where a redesign of the unit would be required to furnish motors of other than the manufacturer's standard design to meet certain requirements of this specification. However, in all cases, totally enclosed motors are preferred, and shall be furnished if offered by the manufacturer as a standard option.
- m. Totally enclosed motors shall be furnished on:
 - (1) Outdoor equipment.
 - (2) Equipment for installation below grade.
 - (3) Chemical feeding and chemical handling equipment.
 - (4) Equipment operating in wet or dust-laden locations.
 - (5) Equipment in indoor, above grade, clean, and dry locations.
- n. Explosion-proof or submersible motors shall be furnished as required by applicable codes, or as otherwise specified.
- o. Motors shall be rated as follows:
 - (1) Below ½-Hp – 115 volts, 60 Hz, single phase; or 240 volts, 60 Hz, single phase.
 - (2) ½-Hp and above – 460 volts, 60 Hz, 3 phase.
- p. All motors shall meet the minimum efficiency standards required by the Energy Policy Act (EPACT) of 1992.
- q. Horizontal motors shall be energy efficient, and shall have a NEMA nominal efficiency nameplate value equal to or greater than values listed in the following table on the following page. Efficiency shall be determined in accordance with IEEE 112, Test Method B.

Motor

Nominal Efficiency Values

<i>Hp</i>	<i>Open Drip Enclosure</i>				<i>TEFC Enclosure</i>			
	<i>3600 rpm</i>	<i>1800 rpm</i>	<i>1200 rpm</i>	<i>900 rpm</i>	<i>3600 rpm</i>	<i>1800 rpm</i>	<i>1200 rpm</i>	<i>900 rpm</i>
1	84.0	83.0	80.5	75.0	75.5	82.5	81.5	75.5
1.5	82.5	84.0	84.5	78.0	84.0	84.0	86.5	80.0
2	84.0	84.0	86.5	86.5	84.0	84.0	87.5	85.5
3	85.0	87.5	88.0	89.5	87.0	88.0	89.0	86.5
5	87.5	88.5	89.0	89.5	88.0	88.0	89.5	85.0
7.5	88.5	89.5	90.0	88.5	90.0	90.0	90.0	86.5
10	89.0	90.0	91.0	91.0	91.0	90.0	91.0	91.0
15	90.2	91.7	91.0	91.0	91.0	92.0	92.0	91.0
20	91.7	92.4	91.7	92.0	92.0	93.0	92.0	91.0
25	92.4	93.0	92.4	92.0	92.0	93.0	93.0	91.0
30	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0
40	93.0	94.0	93.5	93.0	93.0	94.0	94.0	93.0
50	93.0	94.1	93.5	93.0	92.4	94.0	94.0	93.0
60	93.0	95.0	94.5	94.0	93.5	95.0	95.0	93.0
75	94.0	95.0	95.0	94.0	93.6	95.0	95.0	94.0
100	94.5	95.0	95.0	95.0	95.0	95.0	95.0	94.0
125	95.0	95.0	95.0	95.0	95.9	95.0	95.0	94.0
150	95.0	95.0	95.0	95.0	95.0	95.0	95.0	94.0
200	95.0	95.0	95.0	95.0	96.0	96.0	95.0	94.0
250	95.0	95.0	95.0	95.0	94.4	94.5	95.3	94.0

- 6. Drive Units.** The normal input horsepower rating of each gear or speed reducer shall be at least equal to the nameplate horsepower of the drive motor. Drive units shall be designed for 24-hour continuous service.
- a. Gear Motors: Unless otherwise specified, the use of gear motors will not be acceptable.
 - b. Gear Reducers: Each gear reducer shall be a totally enclosed unit with oil or grease lubricated, rolling element, anti-friction bearings throughout.
 - (1) Helical, spiral bevel, combination bevel-helical, and worm gear reducers shall have a service factor of at least 1.50 based on the nameplate horsepower of the drive motor. Cycloidal gear reducers shall have a service factor of at least 2.0 based on the nameplate horsepower of the drive motor. Shaft-mounted and flange-mounted gear reducers shall be rated AGMA Class II. Helical gear reducers shall have a gear strength rating to catalog rating of 1.5. Each gear reducer shall be designed and manufactured in compliance with applicable AGMA standards.
 - (2) The thermal horsepower rating of each unit shall equal or exceed the nameplate horsepower of the drive motor.

During continuous operation, the maximum sump oil temperature shall not rise more than 100°F above the ambient air temperature in the vicinity of the unit, and shall not exceed 200°F.

- (3) Each grease lubricated bearing shall be installed in a bearing housing designed to facilitate periodic re-greasing of the bearing by means of a manually-operated grease gun. Each bearing housing shall be designed to evenly distribute new grease, to properly dispose of old grease, and to prevent over-greasing of the bearing. The use of permanently sealed grease-lubricated bearings will not be acceptable. An internal or external oil pump and appurtenances shall be provided if required to properly lubricate oil-lubricated bearings. A dipstick or a sight glass arranged to permit visual inspection of lubricant level shall be provided on each unit.
 - (4) Gear reducers which require the removal of parts or the periodic disassembly of the unit for cleaning and manual re-greasing of bearings will not be acceptable.
 - (5) Certification shall be furnished by the gear reducer manufacturer indicating that the intended application of each unit has been reviewed in detail by the manufacturer, and that the unit provided is fully compatible with the conditions of installation and service.
- c. Variable Speed Drives: Each mechanical variable speed drive shall have a service factor of at least 1.75 at maximum speed based on the nameplate horsepower of the drive motor. A spare belt shall be provided with each variable speed drive unit employing a belt for speed change. Unless specifically permitted by the detailed equipment specifications, bracket-type mounting will not be acceptable for variable speed drives.
 - d. V-Belt Drives: Each V-belt drive shall include a sliding base or other suitable tension adjustment. V-belt drives shall have a service factor of at least 1.6 at maximum speed based on the nameplate horsepower (kilowatts) of the drive motor.
7. **Safety Guards.** All belt or chain drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gauge or thicker galvanized or aluminum-clad sheet steel or from 1/2-in. mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

8. **Anchor Bolts.** Equipment suppliers shall furnish suitable anchor bolts for each item of equipment. Anchor bolts, together with templates or setting drawings, shall be delivered sufficiently early to permit setting the anchor bolts when the structural concrete is placed. Anchor bolts shall comply with the anchor bolts and expansion anchors section, and, unless otherwise specified, shall be stainless steel and at least 3/4-in. in diameter.

Unless other indicated or specified, anchor bolts for items of equipment mounted on base plates shall be long enough to permit 1-1/2 in. of grout beneath the base plate and provide adequate anchorage into structural concrete.

9. **Equipment Bases.** Unless otherwise indicated or specified, all equipment shall be installed on concrete bases at least 6 in. high. Cast iron or welded steel base plates shall be provided for pumps, compressors, and other equipment. Each unit and its drive assembly shall be supported on a single base plate of neat design. Base plates shall have pads for anchoring all components, and adequate grout holes. Base plates for pumps shall have a means for collecting leakage and a threaded drain connection. Base plates shall be anchored to the concrete base with suitable anchor bolts, and the space beneath filled with grout as specified in the grout section.
10. **Special Tools and Accessories.** Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.
11. **Shop Painting.** All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces, which will be inaccessible after assembly, shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned and filled, as necessary, to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop-primed or finished with an oil-resistant enamel or universal-type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop-painted with one or more coats of the specified primer. Unless other specified, the shop primer for steel and iron surfaces shall be Ameron "Amercoat 385 Epoxy", Carboline "Carboguard 888 Primer", or Tnemec "Series N27 S.T. Typoxy".

Machined, polished, and nonferrous surfaces, which are not to be painted, shall be coated with rust-preventive compound, Houghton "Rust Veto 344".

- 12. Preparation for Shipment by Manufacturers.** All equipment shall be suitably packaged to facilitate handling and to protect against damage during transit and storage.

All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements and shall be kept dry at all time.

Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. Painted surfaces which are damaged prior to acceptance of equipment shall be repaired to the satisfaction of Engineer's or Owner's Representative.

Grease and lubricating oil shall be applied to all bearings and similar items when preparing the shipment.

Each item of equipment shall be tagged or marked as identified in the delivery schedule or on the Shop Drawings. Complete packing lists and bills of material shall be included with each shipment.

- 13. Transportation and Handling of Materials and Equipment.** Arrange deliveries of products in accordance with construction schedules; coordinate to avoid conflict with work and conditions at the site.

Immediately on delivery, inspect shipments to assure compliance with requirements of Contract Documents and approved submittals, and that the products are properly protected and in undamaged condition, in manufacturer's original containers or packaging, with identifying labels intact and legible.

Provide equipment and personnel to handle products by methods to prevent soiling or damage to products or packaging.

- 14. Storage and Protection of Materials and Equipment.**

- a. Upon delivery, all materials and equipment shall immediately be stored and protected in accordance with manufacturer's recommendations until installed in the Work.
- b. Indoors:
 - (1) Store products in accord with manufacturer's instructions, with seals and labels intact and legible.
 - (2) Store products subject to damage by the elements in weather tight enclosures.
 - (3) Maintain temperature and humidity within the ranges required by manufacturer's instructions for all materials and equipment. In general, pumps, motors, electrical equipment, and all equipment with antifriction or sleeve bearings shall be stored in weather tight structures maintained at a temperature above 60°F. Equipment, controls, and insulation shall be protected against moisture and water damage.

- (4) Motor, MCC, and equipment with heaters shall be temporarily connected.
- c. Outdoors:
 - (1) Store fabricated products above the ground, on blocking or skids; prevent soiling or staining. Cover products, which are subject to deterioration with impervious sheet coverings; provide adequate ventilation to avoid condensation.
 - (2) Store loose granular materials in a well-drained area on solid surfaces to prevent mixing with foreign matter.
 - (3) Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to assure that products are maintained under specified conditions, and free from damage or deterioration.
- d. Materials and equipment shall not show any pitting, rust, decay, or other deleterious effects of storage when installed in the Work.
- e. Contractor may store materials and equipment in bonded warehouse off-site subject to Owner's approval.

15. Compliance with Manufacturer's Instructions for Installation and Operation.

- a. All equipment shall not be installed or operated except by, or with the guidance of, qualified personnel having the knowledge and experience necessary to obtain proper results. When so specified, or when employees of the Contractor or its Subcontractors are not qualified, such personnel shall be field representatives of the manufacturer of the equipment or materials being installed. The qualified field representatives shall be provided by each equipment manufacturer.
- b. When Contract Documents require that installation of work shall comply with manufacturer's printed instructions, obtain and distribute copies of such instructions to parties involved in the installation, including 2 copies to the Engineer's or Owner's Representative. Maintain one set of complete instructions at the job site during installation and until completion.
- c. Handle, install, connect, clean, condition and adjust products in strict accord with such instructions and in conformity with specified requirements.
- d. Should job conditions or specified requirements conflict with manufacturer's instruction, consult with the manufacturer for further instructions and notify the Engineer's representative.
- e. Do not proceed with work without clear instructions.
- f. Perform work in accordance with manufacturer's instructions. Do not omit any preparatory step or installation procedure unless specifically authorized in writing by the manufacturer.

- g. Manufacturer shall supply to the Owner a Certificate of Proper Installation that it has been installed in accordance with the manufacturer's instructions.
- h. All equipment installed under this Contract shall be placed into successful operation after proper testing, adjusting, balancing, demonstration, and start-up.

16. Protection After Installation. Provide substantial coverings as necessary to protect installed products from damage from traffic and subsequent construction operations. Remove when no longer needed.

B. Equipment Schedule.

The equipment items that require manufacturers' field services, Certificates of Proper Installation (CPI), Operation and Maintenance Manuals, and/or Operator Training Programs are listed throughout the specifications. The following list is provided for the Contractor's convenience and represents most major equipment requirements.

<i>Type of Equipment</i>	<i>Field Services</i>	<i>CPI</i>	<i>O&M Manual</i>	<i>Operator Training (Days)</i>
Submersible Non-Clog Pumps	X	X	X	1
Miscellaneous Valves and Air/Vacuum Release Valve	X	X	X	½
Check Valves	X	N/A	X	¼
Gate Valves	X	N/A	X	¼
Electrical Equipment	X	X	X	1
Controls Equipment	X	X	X	1
Generator Set	X	X	X	1

This list may not be all inclusive. Failure to list an item of particular equipment in this section does not relieve the manufacturer of any responsibility to complete field services, Certificates of Proper Installation, Operation and Maintenance Manuals, and/or Operator Training Programs.

- C. Manufacturers' Services.** Manufacturer's field services shall include as a minimum:
1. Inspecting existing site facilities prior to starting work and factoring in all constraints in equipment design and configuration.

2. Inspection, checking, and adjustment as required for equipment to function as warranted by manufacturer and necessary to furnish written approval of installation.
3. Performing periodic visits to site during construction to assure installation tolerance and methods meet manufacturer and industry standards.
4. Revisiting the site as required to correct problems and until equipment installation and operation are acceptable to the Owner's and/or Engineer's Representative.
5. Resolution of assembly or installation problems attributable to or associated with, respective manufacturer's products and systems.
6. Assistance during functional and performance testing and start-up demonstration, and until product acceptance by the Owner's and/or Engineer's Representative.
7. Training of Operator's personnel in the operation and maintenance of respective product as required herein.
8. Completion of Manufacturer's Certificate of Proper Installation (form enclosed at end of this section) with applicable certificates for proper installation and initial, interim, and final test or service.

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

COMPANY: _____

EQPT SERIAL NO.: _____

EQPT TAG NO.: _____

EQPT/SYSTEM: _____

PROJECT NO.: _____

SPEC. SECTION _____

I hereby certify that the above-referenced equipment/system has been:

(Check applicable)

- Installed in accordance with Manufacturer's recommendations.
- Inspected, checked, and adjusted.
- Serviced with proper initial lubricants.
- Electrical and mechanical connections meet quality and safety standards.
- All applicable safety equipment has been properly installed.
- System has been performance tested, and meets or exceeds specified performance requirements, (when complete system of one manufacturer).

Comments: _____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate his equipment, and (iii) authorized to make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20_____

Manufacturer: _____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

D. Testing, Adjusting, Balancing, Demonstration, and Startup of Systems.

1. Testing, Adjusting and Balancing.

- a. Preparation:
 - (1) Verify installation of system to be tested is complete and in continuous operation.
 - (2) Verify ambient conditions and related facilities are in full operation.
- b. Procedure:
 - (1) Operate each system through the design performance range consistent with available flows. Adjust, balance, calibrate, and in general, check out the equipment, safety devices, controls, and process system within the design conditions.
 - (2) A condition of acceptance of the requirements of this section shall be the satisfactory operation of the constructed facilities using all specified systems in combination with each other, for a period of 40 hours, unless otherwise specified. Any interruption caused by the malfunction of any constructed item or system shall cause the 40-hour clock to be set to zero and the test restarted. The time need not be continuous, based on malfunctions of associated existing facilities.
 - (3) Submit final reports.

2. Demonstration.

- a. Preparation:
 - (1) Verify equipment has been inspected and certified by the manufacturer and put into operation in accordance with the specifications.
 - (2) Verify equipment and systems are fully operational.
 - (3) Have copies of completed operation and maintenance manuals at hand for use in demonstrations and instructions.
 - (4) Submit schedule of systems demonstrations.
- b. Procedure:
 - (1) Demonstrate operation and maintenance of equipment and systems of Owner's personnel a minimum of 2 weeks prior to date of final inspection.
 - (2) Use operation and maintenance manuals as basis of instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
 - (3) Demonstrate startup, operation, control, adjustment, troubleshooting, servicing, maintenance, and shutdown of each item of equipment at agreed-upon times, at designated location(s).
 - (4) The amount of time required for instruction on each item of equipment and system is that specified in equipment schedule or in individual sections.
 - (5) Prepare and insert additional data in operations and maintenance manuals when need for additional data become apparent during instructions.

- (6) Submit system demonstration reports.

3. Startup.

- a. Inspection by Manufacturer's Representative:
 - (1) Verify that equipment installation complies with manufacturer's and contract requirements.
 - (2) Verify that status of Work meets requirements for starting of equipment and systems.
 - (3) Prepare a field inspection report as specified and Certification of Proper Installation (CPI).

- b. Preparation:
 - (1) Coordinate sequence for startup of various items of equipment and systems.
 - (2) Provide confirmation notice to Owner's Representative 7 days prior to startup of each item of equipment.
 - (3) Have Contract Documents, shop drawings, product data, and operation and maintenance data at hand during entire startup process.
 - (4) Verify that each piece of equipment has been checked for proper lubrication, drive rotation, vibration, belt tension, control sequence, and other conditions which may cause damage.
 - (5) Verify control systems are fully operational in automatic mode.
 - (6) Verify that tests, meter readings, and specific electrical characteristics agree with those specified by electrical equipment manufacturer.
 - (7) Verify wiring to motors and controls required by mechanical work for operational smoke and fire protection demonstrations is complete.
 - (8) Bearings: Inspect for cleanliness; clean and remove foreign matter. Verify alignment; take corrective measures.
 - (9) Drives: Inspect for tension on belt drives, adjustment of varipitch sheaves and drives, alignment, proper equipment speed, and cleanliness. Take corrective action.
 - (10) Motors: Verify that motor amperage agrees with nameplate value. Inspect for conditions which produce excessive current flow and which exist due to equipment malfunction. Take corrective action.

- c. Procedure:
 - (1) The Contractor will execute startup under supervision of responsible manufacturer's representative.
 - (2) The Contractor will place equipment in operation in proper sequence as per manufacturer's recommendations.
 - (3) Submit system startup report.

E. Grouts.

1. Non-Shrink Precision Cement Grout.

a. General:

- (1) Non-shrink precision cement grout shall be a flowable Portland cement based grout having a non-metallic composition and containing a proportioned blend of selected Portland cement, mineral aggregate, water, plasticizing/water-reducing admixtures, and shrinkage compensating agents. The shrinkage agents shall compensate for shrinkage in both the plastic and hardened state. The grout shall meet or exceed the requirements of the Corps of Engineers specification CRD C621 for all consistencies proposed for use. The grout shall provide sulfate resistance comparable to that of Type II cement.
- (2) Non-shrink precision cement grout shall be used in confined and generally formed areas requiring patching. It shall not be used in areas subject to severe chemical attack. It shall not be used under equipment pad base plates subject to vibration.

b. Material: Properties of the cured material:

- (1) Compressive strength per CRD C621 – 7,600 psi minimum at 28 days.
- (2) Splitting Tensile Strength per ASTM C496 – 500 psi minimum at 28 days.
- (3) Flexural Strength per ASTM C 580 – 1,200 psi minimum at 28 days.
- (4) Bond Strength per ASTM C 882-Modified, Plastic to Hardened – 1,950 psi at minimum 28-day moist cure.
- (5) Expansion per CRD C 621 – 0.015 percent minimum at 28 days.
- (6) Color – Concrete gray.

c. Approved Manufacturer's include: Sika Corporation, Lyndhurst, New Jersey – SikagROUT 212; Master Builders, Cleveland, OH – Masterflow 928; U.S. Grout Corporation, Fairfield, CT – Five Star Special Grout applicable to intended use; or approved equal.

2. Non-Shrink Cement Grout.

a. General:

- (1) Non-shrink cement grout shall be a Portland cement based grout having a non-metallic composition and containing a pre-proportioned blend of selected Portland cement, aggregate, water, admixtures, and shrinkage compensating agents. The shrinkage agents shall compensate for shrinkage in both the plastic and hardened state. The grout shall meet or exceed the requirements of the Corps of Engineers specification CRD C621 for all consistencies proposed for use.
- (2) Non-shrink cement grout is intended for use as a general void filler for filling tie holes, blockouts, and minor surface honeycombing and for grouting column and pipe support base plates. It shall not be used in areas designated for “precision” grouting, areas subject to sulfate or chemical attack such as liquid containment structures, or areas subject to vibration from pumps, motors, etc.

- b. Material:** Properties of the cured material
 - (1) Compressive Strength per CRD C621 – 3,000 psi minimum at 3 days; 7,000 psi minimum at 28 days.
 - (2) Expansion per CRD C621 – 0.015% minimum at 28 days; 0.0% shrinkage.
 - (3) Color – Concrete gray.
 - c. Approved Manufacturer's include:** Master Builders, Cleveland, OH – Set Grout; U.S. Grout Corporation, Fairfield, CT – Five Star Grout applicable to intended use; or equal.
- 3. Non-Shrink Epoxy Grout.**
 - a. General:**
 - (1) Non-shrink epoxy grout shall be a non-metallic, polymer-based, composition containing a pre-proportioned blend of epoxy resin, hardener and aggregate.
 - (2) Non-shrink epoxy grout is intended for use in confined and generally formed areas requiring patching or filling. It is particularly intended for use in areas subject to sulfate or chemical attack (such as in liquid containment structures) and under all equipment bases subject to vibration from pumps, motors, etc.
 - b. Material.** Properties of the cured material
 - (1) Compressive Strength per ASTM C579 Method B – 5000 psi minimum at 24 hours; 12,000 psi at 7 days.
 - (2) Tensile Strength per ASTM C307 – 2,000 psi minimum at 28 days.
 - (3) Flexural Strength per ASTM C580 – 4,000 psi minimum at 28 days.
 - (4) Bond Strength per ASTM C882 Modified, Plastic to Hardened – 1,950 psi minimum at 28-day moist cure.
 - (5) Volume change per ASTM C827 modified – 0.0 percent shrinkage.
 - (6) Color – Concrete gray.
 - c. Approved Manufacturer's include.** Sika Corporation, Lyndhurst, NJ – Sikadur 42 Grout Pak; U.S. Grout Corporation, Fairfield, CT – Five Star Epoxy Grout; Master Builders, Cleveland, OH – Ceilcote 648 CP; or equal.
- 4. Polymer Modified Mortar.**
 - a. General:**
 - (1) Polymer Modified Mortar shall be a two-component, polymer-modified, cementitious, fast-setting, trowel grade, structural repair mortar. It shall consist of a factory proportioned two-component system whose components shall not contain chlorides, nitrates, asbestos, added gypsum, added lime, or high alumina cements. The system shall be non-combustible, either before or after cure.
 - (2) It shall be used for general grouting and patching where non-shrink grouts are not required but where increased corrosion resistance is needed such as major repair of defective concrete and honeycombing in water containment structures.

b. Material: Properties of cured material:

- (1) Compressive Strength per ASTM C109 – 250 psi minimum at 4 hours.
- (2) Compressive Strength per ASTM C109 – 7,000 psi minimum at 28 days.
- (3) Flexural Strength per ASTM C78, Modulus of Rupture – 1,300 psi minimum at 28 days.
- (4) Bond Strength per ASTM C882 – 2,200 psi minimum at 28 days.
- (5) Material shall “breathe”, i.e., shall not produce a vapor barrier.
- (6) Material shall be thoroughly compatible with concrete.
- (7) Aggregate may be used to extend the mortar only with the approval of the Engineer.
- (8) System may be finished with power trowel.
- (9) The system must be placeable from 1/8-in. to 1-in. in depth and extendible to greater depths.

c. Approved Manufacturer’s include:

- (1) For horizontal surfaces: Sika Corporation, Lyndhurst, New Jersey – Sikagop 122; Master Builders, Cleveland, OH – SET Vertapatch; Raven Linings, Broken Arrow, OK; or equal.
- (2) For vertical or overhead surfaces: Sika Corporation, Lyndhurst, New Jersey – Sikatop 123; Master Builders, Cleveland, OH – SET Vertapatch; Raven Linings, Broken Arrow, OK; or equal.

- 5. Mixing, Proportioning and Placing.** All grouts shall be mixed and proportioned per the manufacturers’ recommendations. The surfaces against which the grout will be placed shall be cleaned per the manufacturers’ recommendations. The grout shall be placed and cured per the manufacturers’ recommendations.

F. Coatings.

All coatings are to be applied per the manufacturers’ recommendations. This includes shipping, handling, storage, application, curing and protection. The following structures are to be coated: Wet well and valve vault interiors are to be coated with a 80 mil dry film thickness down to 15 foot depth and 125 mil dry film thickness below 15 foot depth of Raven Lining Systems – Raven 405, or approved equal.

Piping, pumps, and valves are to be painted and coated as specified elsewhere in this specification.

- G. Submersible Non-Clog Pumps.** Provide and install two submersible non-clog wastewater pumps and motors, and provide for storage a third matching pump and motor, with power cable, as manufactured by Flowserve Corporation, or an approved equal. Requirements of the pumps are shown on plans

1. Fabrication.

- a. Pump Type: The pumps shall be submersible, non-clogging, and capable of operating at a continuous full-load-duty without external cooling.

The unit shall be shop assembled in the pump manufacturer's plant, accurately aligned, and properly prepared for shipment.

- b. The pump casing shall be a heavy-duty single volute design with an integral centerline discharge flange. The volute shall be constructed of ASTM A48, Class 30 gray cast iron. The pump volute shall be a single high quality casting with smooth passages without blowholes, porosity, or other irregularities. The pump casing discharge flange must meet ANSI flange thickness, dimensions, and bolt pattern.
- c. Impellers shall be constructed of ASTM A48, Class 30 cast iron. Impeller shall be cast in one piece, shall have a minimum number of vanes, and shall be dynamically balanced. The design of the impeller and the shape of the blades shall minimize clogging and still promote efficiency. The impeller shall be keyed to the shaft and firmly held in place by a stainless steel bolt. The arrangement shall be such that the impeller cannot be loosened by torque from either forward or reverse rotation.
- d. Removable cast iron wearing ring shall be provided for the casing. Wear rings made of rubber or other soft materials are not acceptable.
- e. The pump shaft shall be a rigid integral unit, made from Type 416 stainless steel of sufficient size to transmit the full driver horsepower with a liberal safety factor, accurately machined over its entire length and free from any harmful or damaging vibrations. Shaft shall be polished as necessary for mechanical seals. Steel shafts with stainless steel sleeves are not an acceptable alternate.
- f. Each pump shall be provided with bearings both radial and thrust, of the anti-friction type, of ample size to carry all loads imposed under continuous operation, minimizing shaft deflection and excessive heat buildup. Bearings shall be permanently lubricated. Bearings shall be designed in accordance with the ABMA standards for a minimum L-10 life of 50,000 hours.
- g. Each pump shall be fitted with an oil chamber that acts as a barrier between the pumped fluid and motor. The oil chamber shall have accessibility from the exterior of the pump and shall be filled with environmentally safe oil. A moisture sensor probe shall be installed in the oil chamber to detect moisture. Probes located in the motor hosing are not acceptable.
- h. Each pump shall be provided with two mechanical seals. Each seal shall operate independently of the other. The lower mechanical seal shall be located behind the impeller and have silicon carbide seal faces. The upper mechanical seals shall have silicon and carbon seal faces. Each seal shall require neither maintenance nor adjustment. Cartridge type seals and seals containing a common spring between the upper and lower faces shall not be considered equal.

- i. Each pump shall be fitted with Type 316 stainless steel external hardware to prevent corrosion. All external surfaces coming into contact with the pumped fluid, other than stainless steel, shall have an electrostatically applied powder coat, baked on epoxy finish. The coating shall be extremely resistant to sewage and other chemicals normally found in wastewater.
 - j. Cables: Include necessary cables for power connection, moisture detection, and overload protection, sheathed, coded, and suitable for submersible pumps, and of sufficient length for direct connection to the terminal boxes indicated. All cables shall be connected to the pumps and tested at the factory.
 - k. Cable Entry: The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The assembly shall provide ease of changing the cable when necessary using the same entry seal. Epoxies, silicones, or other secondary sealing systems are not acceptable.
 - l. Appurtenances: Nuts, bolts, and fasteners shall be stainless steel. All metal surfaces coming in contact with water, other than stainless steel, shall be coated with an approved sewage-resistant coating. Alternative protective coatings must be approved by the Engineer.
2. **Motor.** Provide and install motors as specified in this specification and as follows:
- a. The pump motor shall be a NEMA B design, induction-type, with a squirrel cage rotor, shell-type design, housed in an air-filled, watertight chamber. The stator windings shall be insulated with moisture-resistant Class H insulation rated for 180°C (356°F). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The motor shall be inverter duty-rated in accordance with NEMA MG1, Part 31. The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable. The use of bolts, pins, or other fastening devices requiring penetration of the stator housing is not acceptable. The motor shall be designed for continuous-duty handling pumped media of 40°C (104°F) and capable of up to 15 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of cast aluminum. Thermal switches set to open at 125°C (260°F) shall be embedded in the stator end coils to monitor the temperature of each phase winding. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection, and shall be connected to the control panel. A leakage sensor shall be provided to detect water in the stator chamber. When activated, the FLS shall stop the motor and send an alarm. Use of voltage sensitive solid state sensors and trip temperature above 125°C shall not be allowed. The thermal switch and FLS shall be connected to a MAS (monitoring and status) monitoring unit. The MAS shall be designed to be mounted in any control panel. The junction chamber containing the terminal board shall be hermetically sealed from the motor by an elastomer compression seal. Connection between the cable conductors and stator leads shall be made with threaded compression-type binding posts permanently affixed to a terminal board. The motor and the pump shall be produced by the same manufacturer.

- b. The combined service factor (combined effect of voltage, frequency, and specific gravity) shall be a minimum of 1.15. The motor shall have a voltage tolerance of $\pm 10\%$. The motor shall be designed for operation up to 40°C (104°F) ambient and with a temperature rise not to exceed 80°C. A performance chart shall be provided upon request showing curves for torque, current, power factor, input/output kW and efficiency. This chart shall also include data on starting and no-load characteristics.
- c. The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need of any splices. The outer jacket of the cable shall be oil-resistant chlorinated polyethylene rubber. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 ft. or greater. The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through run-out.

3. Rail System. The pump shall be provided with a rail system to allow easy removal without entering the wet well. The main base fixture shall be secured to the floor and shall include a 90 degree elbow and mounts for two stainless steel rails to be supplied by the manufacturer. The base fixture shall be designed to receive the connecting pump slide bracket without the need for bolts, nuts, or clamps. The pump discharge will connect to a slide bracket that seals against the base fixture by the weight of the pump.

H. Motor Control Center. Provide a duplex alternating motor control center as shown in the plans and meeting the following requirements:

1. General Requirements.

- a. The duplex alternating control panel shall include the following:
 - (i) NEMA 4X stainless steel enclosures
 - (ii) Safety swing out inner doors
 - (iii) Non-fused main disconnect switch with operator handle on the outer door
 - (iv) Power distribution blocks
 - (v) Fused voltage/phase monitor with white LED push-to-test indicator light
 - (vi) Interior fluorescent work light with door activated limit switch
 - (vii) Molded case motor circuit protectors with operator handles
 - (viii) Molded case circuit breakers
 - (ix) Soft starters with internal bypass contactor with 24VSC power supply
 - (x) 3KVA control transformer (Xi) Individually fused control/alarm circuits (Xii) Duplex GFCI receptacle on inner door (Xiii) Duplex alternating relay with lead pump selector switch
 - (xiv) Adjustable thermostat with electric heater
 - (xv) Adjustable ON delay timer for lag pump delay start
 - (xvi) Red float status LED push-to-test indicator lights
 - (xvii) Amber seal failure LED push-to-test lights

- (xviii) Amber over-temperature LED push-to-test indicator lights
 - (xix) Red soft starter failure LED push-to-test indicator lights
 - (xx) Red pump run LED push-to-test indicator lights
 - (xxi) Green pump off LED push-to-test indicator lights
 - (xxii) Two position horn silence selector switch
 - (xxiii) Three position hand-off-automatic rotary switch
 - (xxiv) Elapsed time meters for both pumps
 - (xxv) Flashing main alarm light and horn
- b. Component Isolation: Mount each component, such as a circuit breaker, combination starter, dry-type transformer or branch circuit panel in a separate compartment and effectively isolate from adjacent units, including buses. Make each component readily accessible and removable from the front of the cubicle.
 - c. Cable Entrance: Make provisions for top and bottom cable entrances for all motor control centers. All cable entrances that connect to the wet-well shall be of the potted, gas sealed type.

2. Incoming Line Section.

- a. Provide three valve type lightning surge arrestors on each incoming line.
- b. Provide a main circuit breaker with ground fault protection, complete with CTs and indicating light.
- c. Provide 120-volt shunt trip attachment and phase failure relay for each main line circuit breaker. The breaker must have interrupting rating equal to or greater than 65,000 RMS amperes symmetrical. Provide a contact for remote monitoring of the breaker trip position.
- d. Provide a transient voltage surge suppressor (TVSS) sized for the main service. The TVSS shall be installed after the main circuit breaker.
- e. Furnish main circuit breakers.

3. Metering Sections.

- a. The metering sections shall contain current and potential transformers with accuracy suitable for use with microprocessor logic devices.
- b. Provide a microprocessor based Multilin PQM device with metering OR Multilin SR 750.

4. Circuit Breakers.

- a. Type:
 - (1) Provide thermal magnetic type (motor circuit protectors not acceptable) circuit breakers, which are quick-make and quick-break on both manual and automatic operation.

- (2) Provide a trip-free trip indicating breaker.
 - (3) Incorporate inverse time characteristics by bimetallic overload elements and instantaneous characteristic by magnetic trip.
 - (4) For 2-pole and 3-pole breakers, provide the common-trip type so that an overload or fault on one pole will trip all poles simultaneously.
 - (5) Handle ties are not acceptable.
 - (6) All breakers shall have 65,000 amperes interrupting rating, unless indicated higher on plans.
- b. Operators: Provide breaker operators mounted through the panel door and permitting operation of the breaker with the door closed.

5. Starters.

- a. Type:
- (1) Provide magnetic, reduced voltage, nonreversing starters unless otherwise indicated. Starter units shall be completely drawout so that units may be withdrawn without disconnecting any wiring. A positive guidance system shall be provided to assure proper alignment of power stabs through vertical bus barriers.
 - (2) Full voltage starter units through NEMA Size 5 shall be the draw up type. Size 6 and larger shall be fixed mounted.
- b. Overload Relays: Include three ambient-compensated adjustable thermal overload relays, one per phase.
- c. Contactors:
- (1) Size contactors according to NEC. Sizes below NEMA 1 are not acceptable.
 - (2) Provide three main poles, the number and type of auxiliary contacts to perform the required functions and two spare auxiliary contacts, one normally open and one normally closed, rated 10 amperes (NEMA contact rating designation A600).
 - (3) Use double break contacts of silver-cadmium oxide or similar material to minimize sticking or welding.
 - (4) Provide contactor coils suitable for continuous operation at 120 volts, 60 hertz.
- d. Unless otherwise indicated larger on the drawings, use the following minimum starter sized for motor horsepower and voltage. Under no circumstances shall smaller sizes be used even if mistakenly shown on the drawings; IEC starters shall not be acceptable.

<i>NEMA Size Starter</i>	<i>Horsepower 400 volt</i>	<i>Horsepower 208 volt</i>
1	Up to 7.5	Up to 5.0
2	20	7.5
3	40	20
4	75	36
5	100	--
6	200	--

6. Fuses. Provide fuses conforming to NEC requirements. Supply ten spare sets of fuses for each different type and size fuse installed.

7. Control Power Source.

- a. 120 volts for control power shall be obtained with the use of a control power transformer. Each starter cubicle shall be equipped with two primary power leads connected to power phases 1 and 2 on the load side of the circuit breaker. Fuse both primary leads using fused pull-out type terminal blocks, appropriately identified. Fuse the secondary line leading from the transformer terminal X1. Ground the line leaving terminal X2.
- b. The control power transformer shall be mounted in the respective cubicle and shall be easily accessible. Transformers mounted behind panels shall not be acceptable.

8. Control Devices. Provide MCC with control devices as shown on drawings and as indicated below. Miniature type devices shall not be acceptable.

- a. Selector Switches: Heavy-duty, oil-tight, maintained contact, with marked nameplate.
- b. Pushbutton Units: Heavy-duty, oil-tight, momentary contact, spring return, NO or NC, as shown, with marked nameplate.
- c. Indicating Lights:
 - (1) Pilot light assemblies shall be heavy-duty, LED type with rated life of 20,000 hours.
 - (2) Neon lamps are not acceptable.
 - (3) Provide green (running) and red (stopped) lenses, plus additional lights as shown.
 - (4) Pilot lights shall be push to test type.
 - (5) Colored lenses shall be screwed on type and the bulbs shall be replaceable from the outside.

- d. Control Relays: Industrial control relays having 120-volt, 60-hertz coils, standard convertible NO or NC 10-ampere, 600-volt contacts and building module feature enabling relay to have up to 12 poles.
 - e. Timing Relays: Electrical time-delay type, having 120-volt, 60-hertz coils, 10 ampere, 600-volt contacts and an adjustable timing range of approximately 0.3 to 30 seconds, unless noted otherwise on the drawings.
- 9. Overload Relays.** Equip overload relays with an auxiliary normally open interlock contact which energizes a control relay when the motor overloads.
- 10. Control Wiring.**
- a. Wiring:
 - (1) Install and test control and small wiring inside each MCC at the factory, including control wiring, instrument and relay wiring, secondary leads from instrument transformers, etc.
 - (2) Neatly and carefully install wiring in suitable wiring gutters or conduits, using standard 600-volt switchboard type, stranded copper tinned plated wire No. 14 AWG or larger.
 - (3) Identify each wire at terminals by means of permanent, sleeve-type wire markers.
 - (4) Secure wiring from hinged doors and panels to enclosure in a manner to allow ample flexibility in bending.
 - (5) Make wiring continuous from terminal to terminal, without splices.
 - (6) NEMA type wiring shall be NEMA 2B unless otherwise specified on plans. All wiring shall be done at the factory. Provide terminal blocks for all external wiring.
 - b. Terminals:
 - (1) Terminate wire on instrument, devices, transformers and terminal blocks by means of fork-tongue connectors under screws, marked in accordance with the manufacturer's wiring diagram.
 - (2) Locate terminal blocks in readily accessible places.
 - (3) Termination blocks and screws shall be tinned plated.
 - c. Spare Contacts: Wire spare contacts to suitably identified terminals for external connections and clearly show these connections on shop drawings.
 - d. Spare Terminals: In addition to specified spare contact terminals, provide six spare terminals on each terminal block provided.
 - e. Spare field wiring: Furnish sufficient terminals to terminate all field wires including spare wires inside the MCC.
- 11. Fuses.** Provide fuses conforming to NEC requirements. Supply ten spare sets of fuses for each different type and size fuse installed.

12. Nameplates.

- a. Main Nameplate: Provide MCC with a stainless steel or equal nameplate prominently displayed on the front, indicating manufacturer's name, address and shop order number, year manufactured, and the following ratings:
 - (1) Nominal voltage rating and frequency.
 - (2) Main bus continuous current rating.
 - (3) Maximum 3-phase RMS symmetrical short circuit current rating.
- b. Caution Signs: Provide caution signs in accordance with OSHA requirements.

13. Moisture Proofing. After all connections have been made, spray all terminals, terminal blocks, and starter (with contact closed) with moisture repelling chemical such as manufactured by CHC corporation or equal. Notify the owner 24 hours prior to spraying each motor control center.

14. Spare Parts. Each control center shall include the following minimum renewal parts in original packaging complete with wiring diagram and installation guide.

- a. Two sets of main contact kits for each size and type starter or contactor shown.
- b. One starter coil for each size and type shown and each voltage shown.
- c. Forty disconnecting type terminal blocks of the size and type included in the motor control center.
- d. Ten extra interlocks each with 1-NO and 1-NC contact for each size starter.
- e. Two control relays of the type supplied for the overload and thermal detector auxiliary relays (each relay will have 2-NO and 2-NC contacts).
- f. Ten lamps and bulbs for each type supplied on the pilot lights.
- g. Ten of each control fuse supplied.
- h. Ten sets of fuses of each size and type for each starter, incoming line, and control power transformer.
- i. One spare breaker (including the main) of each size in MCC.
- j. Three spare overload heaters for each size used, including heater elements of each type.
- k. One spare elapsed time meter for each one installed.
- l. Lot of touch-up paint.

I. SCADA System. Furnish and install SCADA equipment, including antenna, transmitter and connections compatible with Owner's existing SCADA system (if applicable).

J. Emergency Standby Power Generator. Furnish all labor and materials required and install complete, tested and ready for operation the emergency standby power generator, including diesel engine, day tank and auto-transformer switch as shown on the drawings and as specified.

1. Rating. The generator set shall be rated as shown on the plans.

- a. Generator Set – The generator set shall include the following:
 - (1) Vibration isolation

- (2) Level 2 sound enclosure – 75 dBA
- b. Engine System – The engine system shall include the following:
 - (1) Oil drain extension
 - (2) Fuel lock off solenoid
 - (3) Secondary fuel filter
 - (4) Stainless steel flexible exhaust connection
 - (5) Industrial exhaust silencer
 - (6) Closed coolant recovery system
 - (7) UV/Ozone resistant hoses
 - (8) Factory installed radiator
 - (9) Radiator drain extension
 - (10) Battery charging alternator
 - (11) Battery cables
 - (12) Battery tray
 - (13) Solenoid activated starter motor
 - (14) Air cleaner
 - (15) Fan guard
 - (16) Radiator duct adapter
 - (17) Rubber booted engine electrical connections
 - (18) Unit mounted fuel tank with capacity for minimum 24 hours running time at full load
- c. Alternator System
 - (1) UL2200
- d. Control System – The control system shall include the following:
 - (1) Digital Control Panel – Touch screen
 - (2) Programmable Crank Limiter
 - (3) 7 day programmable exerciser
 - (4) Special applications programmable PLC
 - (5) RS-232
 - (6) RS-485
 - (7) All-phase sensing DVR
 - (8) Full system status
 - (9) Utility monitoring with auto-transfer switch
 - (10) Two wire start compatible
 - (11) Power output (kW)
 - (12) Power factor
 - (13) Reactive power
 - (14) All phase AC voltage
 - (15) All phase currents
 - (16) Oil Pressure
 - (17) Coolant temperature
 - (18) Coolant level
 - (19) Fuel Pressure
 - (20) Engine speed
 - (21) Battery voltage
 - (22) Frequency

- (23) Date/Time fault history (Event log)
- (24) UL2200 GEN protect
- (25) Isochronous governor control
- (26) -40° C to 70°C Operation
- (27) Waterproof plug-in connectors
- (28) Audible alarms and shutdowns
- (29) Not in auto (Flashing light)
- (30) On/Off/Manual switch
- (31) E-Stop (Red Mushroom – Type)
- (32) NFPA 110 Level I and II (Programmable)
- (33) Remote communication – RS232
- (34) Remote communication – Modem

e. Alarms

- (1) Oil Pressure (Pre-programmed low pressure shutdown)
- (2) Coolant temperature (Pre-programmed high temp shutdown)
- (3) Coolant level (Pre-programmed low level shutdown)
- (4) Oil temperature
- (5) Fuel pressure
- (6) Engine speed (Pre-programmed over speed shutdown)
- (7) Voltage (Pre-programmed Overvoltage shutdown)
- (8) Battery voltage

f. Acceptable Manufacturers:

- (1) Generac
- (2) Cummins
- (3) Onan
- (4) Stewart and Stevenson
- (5) Caterpillar
- (6) Kohler
- (7) Or approved equivalent

K. Pipe, Fittings, Manholes, Force Main, Removal of Existing Lift Station and Appurtenances. Piping, Fittings, Manholes, Force Mains, Removal of Existing Lift Station and Appurtenances shall meet the requirements of the special specifications for Sanitary Sewer and Sewer Force Mains and as shown on the plans, except any separate payment provisions shall not be applicable and all cost shall be included in the lump sum bid price for the lift station:

- 3. Construction.** Construct the lift station as shown in the plans and per these specifications. Excavate and backfill as required to complete the work as outlined in this specification, in accordance with construction requirements of Item 400, “Excavation and Backfill for Structures,” except for measurement and payment.

Construct the lift station wet well and valve vault as outlined in these specification, in accordance with construction requirements of Item 420, "Concrete Structures," Item 421, "Hydraulic Cement Concrete," Item 440, "Reinforcing Steel," and Item 449, "Anchor Bolts," except measurement and payment, and as shown on the plans.

Install the wastewater lines, yard piping, and force main as outlined in this specification, and as shown on the plans. Complete the site work including the site concrete and chain link fence as shown on the plans and in accordance with the requirements of Item 422, "Reinforced Concrete Slab," and Item 550, "Chain Link Fence," except for measurement and payment.

The Contractor is responsible for coordinating all work and paying all fees for connecting the water service for the lift station. The Contractor shall furnish all materials and labor necessary to install the water service.

Secure all necessary permits and furnish, install, maintain, and remove all temporary electric service facilities for construction purposes. In addition, pay for all electrical energy consumed for construction purposes for all subcontractors including the operation of ventilating equipment, heating of buildings, and testing and operating of all equipment after permanent wiring has been installed, until final acceptance by the Owner or until the Engineer certifies Substantial Completion. The Contractor shall be responsible for determining total temporary electrical needs, and shall provide it accordingly. The temporary electrical service shall meet NEC, OSHA, and all other local safety codes.

Furnish and install per the manufacturers' recommendations and these specifications all mechanical systems, valves, piping, pumps and motors. Provide complete testing and operation of all equipment until final acceptance and the facility has been turned over to the permanent operator.

Design, furnish and install the complete electrical and control system, emergency standby generator and SCADA system as outlined in the plans, this specification and Item 618, "Conduit," Item 620, "Electrical Conductors," Item 621, "Tray Cable," Item 622, "Duct Cable," Item 624, "Ground Boxes," and Item 628, "Electric Services," except for measurement and payment.

The Contractor shall conduct a functional test of the generator. This test shall document that the generator starts and that the Automatic Transfer Switch transitions from utility power to generator power upon loss of utility power. The detailed test procedure is to be submitted to the Engineer for approval prior to the test.

Provide training for the personnel that will be responsible for operating and maintaining the lift station as detailed in this specification. Perform all required testing, cleanup, and startup on the facility. Operate the lift station once the wastewater flows have been transferred over until ownership and operation is transferred to the owner. Provide an operation and maintenance manual for the complete installation; this includes all mechanical, electrical, and control equipment and systems.

A. Training and Testing. Provide training and testing as outlined under the various materials included in this specification. In addition to the training and testing for the various pieces of equipment, provide training and testing for the completed system.

B. Operation and Maintenance Manual. Provide Operation and Maintenance Manuals for all equipment. As a minimum the Operation and Maintenance Manual should include the following:

1. For architectural products, applied materials, and finishes include:
 - a. Manufacturer's data giving full product information.
 - b. Catalog number, size, and composition
 - c. Color and texture designations
 - d. Information required for reordering specially manufactured products.
 - e. Instructions for care and maintenance.
 - f. Manufacturer's recommendation for types of cleaning agents and methods
 - g. Cautions against cleaning agents and methods which are detrimental to product
 - h. Recommended schedule for cleaning and maintenance
2. For moisture protection and weather exposure products include:
 - a. Manufacturer's data giving full product information.
 - b. Applicable standards
 - c. Chemical composition
 - d. Details of installation
 - e. Instructions for inspection, maintenance, and repair.
3. For each unit of equipment and system include:
 - a. Description of unit and component parts including function, normal operating characteristics, and limiting conditions.
 - b. Performance curves, engineering data and test.
 - c. Complete nomenclature and commercial number of replaceable parts.
 - d. Operating procedures including Startup, break-in, routing, and normal operating instructions.
 - e. Regulation, control, stopping, shutdown, and emergency instructions
 - f. Summer and winter operating instructions
 - g. Any special operating instructions that may be required
 - h. Maintenance procedures for routine operations
 - i. Guide to troubleshooting
 - j. Disassembly, repair, and re-assembly
 - k. Alignment, adjustment, and checking
 - l. Servicing and lubrication schedule
 - m. List of lubricants required
 - n. Manufacturer's printed operating and maintenance instructions
 - o. Description of sequence of operation by control manufacturer
 - p. Original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance
 - q. Predicted life of parts subject to wear
 - r. Items recommended to be stocked as spare parts

- s. As-installed control diagrams by controls manufacturer
 - t. Each contractor's coordination drawings
 - u. As-installed color-coded piping diagrams
 - v. Charts of valve tag numbers with location and function of each valve
 - w. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage
 - x. Other data as required under pertinent sections of the specifications
4. For each electric and electronic system include:
- a. Description of system and component parts
 - b. Function, normal operating characteristics, and limiting conditions
 - c. Performance curves, engineering data, and tests
 - d. Complete nomenclature and commercial number of replaceable parts
 - e. Circuit directories of panel boards
 - f. Electrical service
 - g. Controls
 - h. Communications
 - i. As-installed color-coded wiring diagrams
 - j. Operating procedures
 - k. Routine and normal operating instructions
 - l. Sequences required
 - m. Special operating instructions
 - n. Maintenance procedures
 - o. Routine operations
 - p. Guide to troubleshooting
 - q. Disassembly, repair, and re-assembly
 - r. Adjustment and checking
 - s. Manufacturer's printed operating and maintenance instructions
 - t. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.

MAINTENANCE SUMMARY FORM

PROJECT: _____ CONTRACT NO.: _____

1. EQUIPMENT ITEM _____

2. MANUFACTURER _____

3. EQUIPMENT/TAG NUMBER(S) _____

4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS) _____

5. NAMEPLATE DATA (hp, voltage, speed, etc.) _____

6. MANUFACTURER'S LOCAL REPRESENTATIVE _____

a. Name _____ Telephone No. _____

b. Address _____

7. MAINTENANCE REQUIREMENTS

<i>Maintenance Operation Comments^a</i>	<i>Frequency^b</i>	<i>Lubricant (If Applicable)^c</i>

a. List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)

b. List required frequency of each maintenance operation.

c. Refer by symbol to lubricant list required.

8. LUBRICANT LIST

<i>Reference Symbol^a</i>	<i>Shell^b</i>	<i>Standard Oil^b</i>	<i>Gulf^b</i>	<i>Arco^b</i>	<i>Or Equa^b</i>

a. List symbols used in No. 7 above.

b. List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.

9. RECOMMENDED SPARE PARTS FOR ONE YEAR OF OPERATION

<i>Part No.</i>	<i>Description</i>	<i>Unit</i>	<i>Quantity</i>	<i>Unit Cost</i>

10. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY^a

<i>Part No.</i>	<i>Description</i>	<i>Unit</i>	<i>Quantity</i>	<i>Unit Cost</i>

a. Identify parts provided by this Contract with two asterisks.

- 4. Measurement.** The lift station will be measured by each complete in place. Measurement will begin at and include the chain link fence. All work inside the fence will be considered part of the lift station, plus all needed electrical work and paving outside the chain link fence shown on the plans and needed to provide a fully functional installation. This includes the site work, yard piping, electric service, emergency standby generator, wiring, control panels, power distribution panels, instrumentation, excavation, special shoring, backfill, wet well, valve vault, pumps and motors, valves, piping, pipe supports, grating, hatches, ventilation, and all other items that may not be specifically mentioned here, but are needed for the lift station. Training, testing, startup, and preparation of the Operation and Maintenance Manuals are not measured separately for payment. Removal of the existing lift station shall also be included in the measurement of the lift station.
- 5. Payment.** Payment for the lift station will at the unit price bid for “lift station” of type specified. It will be full payment for furnishing and installing all materials, tools, labor, supervision, and incidentals necessary to construct the lift station complete in place including: the chain link fence, site work including paving inside the fence, yard piping, electric service, emergency standby generator, wiring, control panels, power distribution panels, instrumentation, excavation, special shoring, backfill, wet well, valve vault, pumps and motors, valves, piping, pipe supports, grating, hatches, ventilation, and all other items that may not be specifically mentioned, including removal of the existing lift station. Training, testing, startup, and preparing the Operation and Maintenance Manuals are also considered part of the payment for “Lift Station.”